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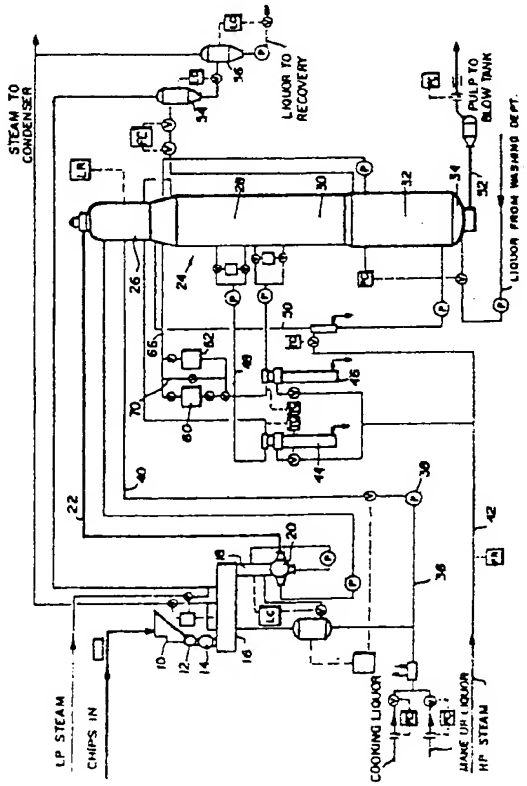
(54) Apparatus and methods for reducing the formation of scale in pulping operations.

(57) A retention vessel (60) for the liquor heated by the lower heat exchanger in a continuous digester (24) is provided. The lower heat exchanger (46) heats the liquor to a temperature above which the calcium in solution precipitates. The liquor is retained in the retention vessel (60) for a predetermined time sufficient for the calcium to either deposit as scale on the surfaces of the vessel (60) or to flow through the system with the chips. In this manner, the scale-forming constituents of the liquor are reduced and a scale-forming constituent lean liquor is returned to the digester (24), whereby the tendency of the liquor to form scale on the component parts of the pulping system is minimized.



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APPARATUS AND METHODS FOR REDUCING THE FORMATION OF SCALE IN PULPING OPERATIONS

BACKGROUND AND SUMMARY OF THE INVENTION

The present invention relates to apparatus and methods for reducing the formation of scale in pulping operations and particularly relates to apparatus and methods associated with the digester of a continuous cooking system for pulp for thermally deactivating a scale-forming constituent, e.g., calcium carbonate, of the liquor whereby a calcium-lean liquor is provided the pulping operation.

The tendency of scale to form and build up in pulping operations, and particularly in the commonly used digesters of continuous cooking systems where impregnation, heating, cooking and washing of the cellulosic material takes place in one or more towers, has long been a problem. The scale can form in various zones of the digester, for example, in the upper cooking zone and in the heaters. Scale also appears downstream in the cooking, extraction and quench zones, evaporators and in other system parts. Scale buildup in these various zones and parts of the pulping operation have various deleterious effects on its overall operation. For example, scale buildup on screens inhibits liquid flow. As a further example, heater tubes in the heat exchangers are frequently blocked and the rate of heat exchange deteriorates with scale buildup. Thus, the overall efficiency of the process generally diminishes as scale builds up.

The origin of the scale deposits in pulping operations appears to emanate from calcium in the cellulosic chips which is dissolved in the liquor and, to a limited extent, from the liquor itself. The scale deposits themselves comprise largely calcium carbonate. As indicated previously, the problem of scaling is not new and efforts have been made to reduce or eliminate the magnitude of scaling in digesters. For example, periodic acid washing in situ of the component parts of the pulping apparatus has been tried and suggested as a solution to the scaling problem. However, acid washing has certain drawbacks, including the formidable expense of the acid itself as well as the required downtime of the pulping plant necessary to permit acid washing. For example, it is not uncommon to have two days downtime for each acid cleaning. On-line acid cleaning of various components of the pulping system has also been attempted. Here again, however, chemical costs have been high and such methods have not proven to be completely effective.

It has been appreciated that calcium normally enters the cooking system of the digester with the cellulosic chips, white liquor and wash water, the majority of the calcium entering the system with the chips. The calcium in the system is dissolved during the steaming and impregnation portions of the process and forms complexes with the dissolved lignin compounds. These complexes are stable in solution up to a predetermined temperature, for example, normally between about 300 to 330° F. Once this predetermined temperature is exceeded, the calcium ion of the previously stable complexes is released and rapidly combines with the carbonate ion to form calcium carbonate. The calcium carbonate deposits as scale on adjacent surfaces, particularly on heated surfaces. Once sealing starts, crystal growth proceeds rapidly.

According to the present invention, one or more sacrificial retention vessels are introduced into the pulping system, preferably at a location adjacent or directly downstream of one or more areas of the system at which temperatures above this predetermined temperature are obtained. For example in a single-vessel continuous digester, a slurry temperature in excess of this predetermined temperature occurs immediately after the lower cooking circulation heater. This happens to correspond to the hottest point in a continuous digester system. Other areas in a single-vessel digester where such temperatures occur include the inlet and outlet of the upper heater and the inlet to the lower heater. In a two-vessel digester, such areas would occur adjacent the inlet or outlet of the bottom circulation heaters. By locating a retention vessel at one of these points in the system and retaining the liquor at these elevated temperatures for a predetermined length of time, the calcium can be made to precipitate as calcium carbonate and either plate out on the walls of the retention vessel or be carried through the pulping system with the cellulosic material. Thus, the scale-forming constituent is weaned from the liquor such that when the liquor is returned to the pulping system, the slurry constitutes a mixture lean of scale-forming constituents. This scale-forming constituent deactivating vessel can be readily taken off-line, cleaned and returned to the system without system downtime. This can be accomplished simply by diverting the liquor flow from the heat exchanger directly back into the digester while the retention vessel is being cleaned. (Present continuous digester systems flow the liquor from the heat exchanger directly back into the digester)

Alternatively, an additional retention vessel may be used whereby thermal deactivation of the scale-

forming constituent may be continued by flowing the liquor to the additional retention vessel while the off-line retention vessel is cleaned. In this manner, downtime for cleaning the pulping system is greatly reduced or completely eliminated. Chemical addition and its attendant costs are greatly reduced or completely eliminated by the present system. More importantly, the deleterious effects of scaling are minimized or eliminated, thereby reducing or eliminating operational instabilities, mechanical system breakdowns and decreased pulp quality resultant from scaling.

Thus, it will be appreciated that the commonly used continuous digester pulping process may be readily adapted to the present scale-forming prevention system. Particularly, the liquor drawn from the heating zone of the digester, and either before or after passing through the heat exchanger external to the digester, is disposed for a predetermined time period in the retention vessel prior to its return to the digester. In that retention vessel external to the digester, calcium precipitates out of solution and forms as scale on the surfaces of the vessel or forms an insoluble chemical structure which passes through the system without deposition as scale. The liquor which is returned to the digester is thus a liquor lean of the scale-forming constituent, i.e., calcium. Consequently, the major system components of the digester are not contacted with a liquor rich in calcium-originated scale-forming constituents. Rather, they are contacted by a liquor which has reduced scale-forming calcium-originated constituents. Alternatively, the precipitated scale-forming constituents may be returned to the slurry in the digester without scaling out on the surfaces of the retention vessel. Thus, the slurry with the precipitated calcium would flow through the system without forming scale on its component parts.

Accordingly, in accordance with a preferred embodiment of the present invention, there is provided a method for reducing the formation of scale in an apparatus for treating cellulosic material, including a treatment vessel, for example a digester, containing a slurry of cellulosic chip material in a liquor, and a scale-forming constituent dissolved in the slurry, comprising the steps of separating at least part of the liquor together with at least a portion of the dissolved scale-forming constituent from the slurry, heating the separated liquor to a predetermined temperature and retaining the heated liquor at such temperature for a predetermined period of time effective to cause the scale-forming constituent portion to precipitate out of solution and recombining the heated liquor with the slurry in a treatment vessel whereby the precipitated scale-forming constituent portion is not available to form scale in the subsequent treatment of the cellulosic material.

In accordance with another aspect of the present invention, there is provided apparatus for reducing the formation of scale in the treatment of cellulosic material comprising a treatment vessel for containing a slurry of cellulosic chip material and liquor in a scale-forming constituent dissolved in the slurry.

Means are carried by the treatment vessel for separating at least a portion of the liquor and a corresponding portion of the dissolved scale-forming constituent from the cellulosic material. A heat exchanger external of the treatment vessel and in communication with the separating means is used to heat the separated liquor and scale-forming constituent portion to a predetermined temperature to cause the scale-forming constituent to precipitate out of solution. A retention vessel is provided in communication with the heat exchanger for receiving the heated liquor and retaining it for a predetermined time period effective to cause the scale-forming constituent portion to precipitate out of solution. Means are connected between the retention vessel and the treatment vessel for returning the heated liquor to the treatment vessel whereby the scale-forming constituent portion is not available to form scale in subsequent treatment of the cellulosic material in the apparatus.

In another aspect of the present invention, the system may be operated with a single retention vessel. When the sacrificial retention vessel has sufficient scale deposits to warrant cleaning, the flow of heated liquor is diverted back directly to the digester rather than through the retention vessel. In this manner, the retention vessel may be cleaned while the digester is maintained in continuous operation until such time as the cleaned retention vessel may be placed back on-line. Alternatively, an additional retention vessel may be provided such that the flow of heated liquor may be diverted from one to the other of the retention vessels. In this manner, the off-line retention vessel may be cleaned, while the on-line retention vessel continues to serve the function of reducing the scale-forming constituent in the liquor to provide a liquor for flow through the system which is lean in the scale-forming constituent.

Accordingly, it is a primary object of the present invention to provide novel and improved apparatus and methods for reducing the formation of scale in a pulping process without chemical addition, in a manner which admits of retrofitting existing pulping systems, as well as equipping new systems, and which enables the system to enjoy the advantages and benefits of a pulping system with reduced scale deposits.

These and further objects and advantages of the present invention will become more apparent upon reference to the following specification, ap-

pended claims and drawing.

BRIEF DESCRIPTION OF THE DRAWING FIGURE

The sole drawing Figure 1 is a schematic view of a pulping system constructed in accordance with the present invention.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawing figure.

Referring to the drawing Figure 1, there is illustrated a continuous cooking system modified to incorporate the present invention whereby the tendency of the slurry in the system to form scale is eliminated or reduced. Particularly, there is illustrated the major elements of a conventional pulp cooking system, including a chip hopper 10, a metering device 12, and a low-pressure feeder 14 for feeding cellulosic material, i.e., chips, into a pre-steaming vessel 16. The pre-steamed chips are fed from pre-steamer 16 into a chip chute 18 and a high pressure feeder 20 is used to flow the chips through line 22 to a single-vessel digester, generally designated 24.

As well known, digester 24 includes a digester impregnation zone 26 for impregnation of the chips, a digester heating zone 28 with liquor circulation for heating the chips to cooking temperature, a digester cooking zone 30 for cooking the chips at the desired temperature, a washing zone 32, in this case, a countercurrent washing zone, and a lowermost cooling zone 34. Cooking liquor and make-up liquor are supplied by a high-pressure pump 38 through a line 36 to the impregnation zone via line 40.

To heat the liquor in the digester, high-pressure steam is provided through line 42 to upper and lower heat exchangers 44 and 46 external to digester 24. The steam indirectly heats the liquor withdrawn from the heating zone and the heated liquor is circulated back to the digester to elevate the temperature of the slurry to its cooking temperature. Heat exchangers 44 and 46 communicate with upper and lower portions of the digester via lines 48 and 50, respectively, whereby liquor is pumped from the heating zone 28 into the heat exchangers 44 and 46, respectively, for return to the digester at an elevated temperature. After cooking and washing, the cooled, cooked chips are discharged from digester 24 by way of line 52. Additionally, flash tanks 54 and 56 are employed to generate steam for pre-steaming the chips in the pre-steamer 16 and for hot water preparation.

The foregoing brief description of drawing Figure 1 refers to a conventional part of a continuous cooking system. As set forth above, scale-forming constituents are dissolved in the liquor and those constituents primarily emanate from the wood chips. The scale-forming constituents are principally calcium, which conventionally scale-out as calcium carbonate on the surfaces of the cooking system. Thus, the scale deposits normally occur within the digester and ancillary components, for example, on the screens, not shown, used to withdraw the liquor from the digester for flow to the heat exchangers, an associated piping and also on the heat exchangers themselves. In accordance with the present invention, the liquor is weaned of the scale-forming constituent such that a scale-forming constituent lean liquor is returned to the digester 24.

According to the present invention, there is provided a liquor retention vessel 60, for example, disposed between the outlet side of the lower heat exchanger 46 and the return line 66 for returning the heated liquor from heat exchanger 46 to the digester. Thus, liquor heated by the upper heat exchanger 44 and returned to the digester is withdrawn by the lower heat exchanger 46 and heated to a still higher temperature at least above the temperature at which the scale-forming constituent precipitates out of solution. It has been found that the complexes of calcium with dissolved lignin compound are stable up to about 300 to 330° F. When the liquor is heated above such temperature, the calcium complex is destroyed and calcium forms a scale with carbonate. The liquor is introduced into the retention vessel 60 at such elevated temperature and retained in the retention vessel for a predetermined period of time. Thus, the liquor is retained in the retention vessel at a temperature and for a predetermined time effective to precipitate the calcium from solution and enable the calcium carbonate to either plate-out on the walls of the vessel or be carried as an insoluble component of the slurry and chips through the cooking system when the liquor is returned to the digester. That is, the retention vessel 60 is a sacrificial vessel which weans the scale-forming constituent from the heated liquor such that the liquor returned from the retention vessel to the digester is scale-forming constituent lean or calcium deficient. Consequently, the liquor returned to the digester prior to cooking the chips has reduced scale-forming constituents, thus reducing the tendency of scale to form and deposit on various component parts of the digester and subsequent components

of the cooking system.

The magnitude of any resultant scaling in the digester system when using the present invention appears to be a direct function of time and temperature during retention. For example, recent pilot tests have indicated a liquor retention time of fifteen minutes at 314-320°F reduced scaling by 75%, whereas a retention time of seven minutes at the same temperature range reduced scaling by 50%. These results are based on the location of the retention vessel in a two-vessel digester adjacent the inlet to the bottom circulation heaters. Consequently, it would appear that the temperature must be elevated above about 300°F for a period of time of five minutes or more. Preferably, a treatment time of 10-20 minutes at about 300-320°F is adequate to deactivate most calcium sealing liquors.

A second retention vessel 62 may be provided in parallel with the first vessel 60 such that one or the other of the retention vessels may be used on-line, thereby continuously affording a lean liquor, while the off-line retention vessel is cleaned of scale. Alternatively, where only a single retention vessel 60 is provided, the liquor from the lower heat exchanger may be returned to the digester directly via line 70, bypassing retention vessel 60, for the limited period of time during which retention vessel 60 is off-line and being cleaned of scale. Once cleaned of scale, the retention vessel 60 would be returned in-line.

As indicated previously, the retention vessel may be located, in a single-vessel digester system, adjacent the outlet or inlet of the upper heater or the outlet or inlet of the lower heater. In a two-vessel digester system, the retention vessel may be located adjacent the inlet or outlet of the bottom circulation heaters.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment, but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

Claims

1. In a continuous cooking system for pulping operations including a digester (24) for containing cellulosic chips and a liquor containing active cooking chemicals wherein the chips and liquor have a scale forming constituent dissolved in solution in the digester, a process for reducing the formation of scale characterized by the steps of:

(a) heating the liquor to a predetermined temperature and retaining the heated liquor at such temperature for a predetermined time period effective to cause the scale forming constituent to precipitate out of solution to provide a liquor lean of the scale forming constutient; and

(b) subsequently, in the digester, cooking the chips in said lean liquor whereby the scale forming constituent is not available to form scale in subsequent pulping operations.

2. A process according to Claim 1 wherein step (a) is performed externally of said digester (24), and including the further step of retaining the heated liquor at such temperature in a retention vessel (60) external to said digester for a time period such that the scale forming constituent plates out on the surfaces of the retention vessel.

3. A process according to Claim 2 wherein step (a) is performed by a heat exchanger (44) external to said digester (24), and including the further steps of alternately flowing the heated liquor (a) from the heat exchanger to the retention vessel (60) and then to the digester or (b) from the heat exchanger directly back to the digester bypassing the retention vessel whereby the retention vessel may be periodically cleaned of scale.

4. A process according to Claim 1 wherein step (a) is performed externally of said digester, and including the further steps of returning the heated liquor to said digester (24), and retaining the heated liquor in a retention vessel (60) while external to said digester at such temperature and for said time period such that the precipitated scale forming constituent flows back to the digester with the heated liquor for flow with the chips through the digester.

5. A process according to Claim 1 wherein said predetermined temperature is at least 300°F and said predetermined time period is at least fifteen minutes.

6. A process according to Claim 1 including the steps of prior to performing steps (a) and (b) separating at least part of the liquor together with at least a portion of the dissolved scale forming constituent from the slurry and prior to performing step (b) recombining the separated heated liquor with the slurry in the digester whereby the precipitated scale forming constituent portion is not available to form scale in the subsequent treatment of the cellulosic material.

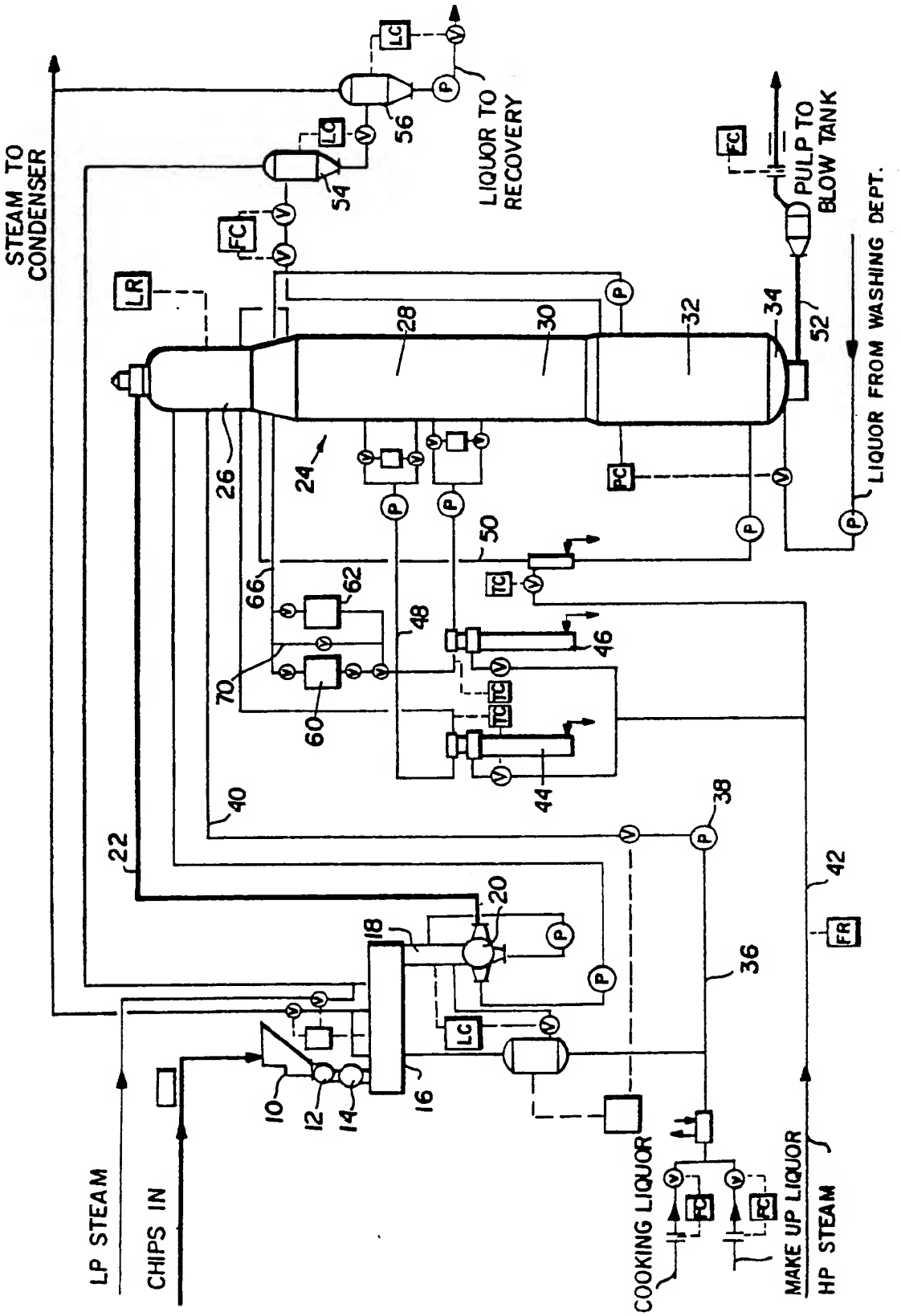
7. A process according to Claim 6 wherein step (a) is performed by a heat exchanger (44) external to said digester, and including the further steps of alternately flowing the heated liquor (a) from the heat exchanger to a retention vessel and then to the digester or (b) from the heat exchanger directly

back to the digester bypassing the retention vessel (60) whereby the retention vessel may be periodically cleaned of scale.

8. In a pulp treatment apparatus having a treatment vessel (24) for containing a slurry of cellulosic chip material and liquor and a scale forming constituent dissolved in the slurry, and a heat exchanger (44) external to and in communication with said treatment vessel for heating a portion of the liquor and returning the heated liquor from the heat exchanger to the treatment vessel, apparatus for reducing the formation of scale in the treatment of the cellulosic material characterized by a retention vessel (60) in communication with said heat exchanger (44) for receiving the heated liquor and a scale forming constituent portion of the slurry heated therewith in the heat exchanger to a predetermined temperature sufficient to cause the scale forming constituent portion to precipitate out of solution, said retention vessel retaining the heated liquor and scale forming constituent portion at said predetermined temperature for a predetermined period of time effective to cause the scale forming constituent portion to precipitate out of solution to provide a liquor lean of the scale forming constituent for return to said treatment vessel whereby the scale forming constituent portion is not available to form scale in subsequent treatment of the cellulosic material in the apparatus.

9. Apparatus according to Claim 8 including a second retention vessel in communication with said heat exchanger and said treatment vessel, and means for selectively flowing the heated liquor from said heat exchanger to one of the first mentioned and second retention vessels to enable the other of said first mentioned and said second retention vessels to be cleaned of scale deposits for reuse.

10. Apparatus according to Claim 8 wherein said treatment vessel comprises a continuous digester having chip impregnation, heating, cooking and washing zones for serial flow of the slurry therethrough in that order, said digester having upper and lower heat exchangers external thereto, said lower heat exchanger constituting the first mentioned heat exchanger in communication with said retention vessel.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EUROPEAN SEARCH REPORT

Application Number

EP 88 11 1367

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	FR-A-2 583 079 (AHLSTROMFORETAGEN) * Figure 1; claim 1; page 1, lines 1-24; page 2, lines 30-37 *	1,2,5,8	D 21 C 3/22 D 21 C 7/00
A	US-A-1 945 205 (L.D. SMILEY) * Whole document *	2,8	
A	US-A-2 008 839 (T. SAMSON)		
A	TAPPI, vol. 63, no. 4, April 1980, pages 125-127, Atlanta, US; L.D. MARKHAM et al.: "Formation of calcium carbonate scale in a continuous digester"		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

D 21 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31-01-1989	NESTBY K.

CATEGORY OF CITED DOCUMENTS

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